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# FINAL
# MATERIALS MANAGEMENT PLAN
# PHASE II AND III CONSTRUCTION
# I-70 MODIFICATIONS
# HUMBOLDT/44TH STREETS TO
# BRIGHTON BOULEVARD
# DENVER, COLORADO

Walsh Project Number: 3008-020
CDOT Project Number: IR-IM(CX)070-4(145)
July 24, 1998

Walsh

Environmental Scientists and Engineers, Inc.

ADMINISTRATIVE RECORD

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July 24, 1998

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STATE OF COLORADO

**DEPARTMENT OF TRANSPORTATION**
Region 6

2000 South Holly Street
Denver, Colorado 80222
(303) 757-9935

August 3, 1998

**Subject: Distribution of Phase II and III Site Investigation Report and Materials Management Plan, CDOT Project No. IR-IM(CX)070-4(145), I-70 Viaduct Reconstruction**

To: Distribution List

Enclosed for your use are copies of the following documents prepared by Walsh Environmental on behalf of the Colorado Department of Transportation, Region 6.

- Site Investigation (Final), I-70 Phase II and III Construction, 44th Street to Brighton Boulevard, City and County of Denver, Colorado, dated July 23, 1998; and
- Materials Mange Plan (Final), I-70 Phase II and III Construction, 44th Street to Brighton Boulevard, City and County of Denver, Colorado, dated July 24, 1998.

Please call me at 757-9935 if you have any questions. Thank you very much.

Sincerely,

Marc K. Morton

Marc K. Morton
Environmental Project Manager

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# DENVER, COLORADO

July 23, 1998

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Walsh Project No. 3008-020
CDOT Project Number: IR-IM(CX)070-4(145)

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## 1 INTRODUCTION

### 1.1 Objectives

This Materials Management Plan is designed to detail the procedures which must be followed during the Phase II and III construction activities for modifications of I-70 from Humboldt/44th Streets to Brighton Boulevard (CDOT Project Number IR-IM(CX)070-4(145)). The Materials Management Plan (MMP) is intended to aid in the prevention of environmental contamination, to ensure safe handling of known and potentially contaminated materials, and to ensure compliance with applicable environmental regulations pertaining to the handling of the waste materials which may be encountered during this project. The project vicinity is shown in Figure 1.

The primary goal of this program is to limit worker exposure to contaminated soil and ground water and to prevent any of the known or potentially contaminated materials which may be encountered on this project from impacting the water quality in the South Platte River. The procedures included in this plan have been developed to manage contaminated and suspect materials in a manner which will minimize this impact.

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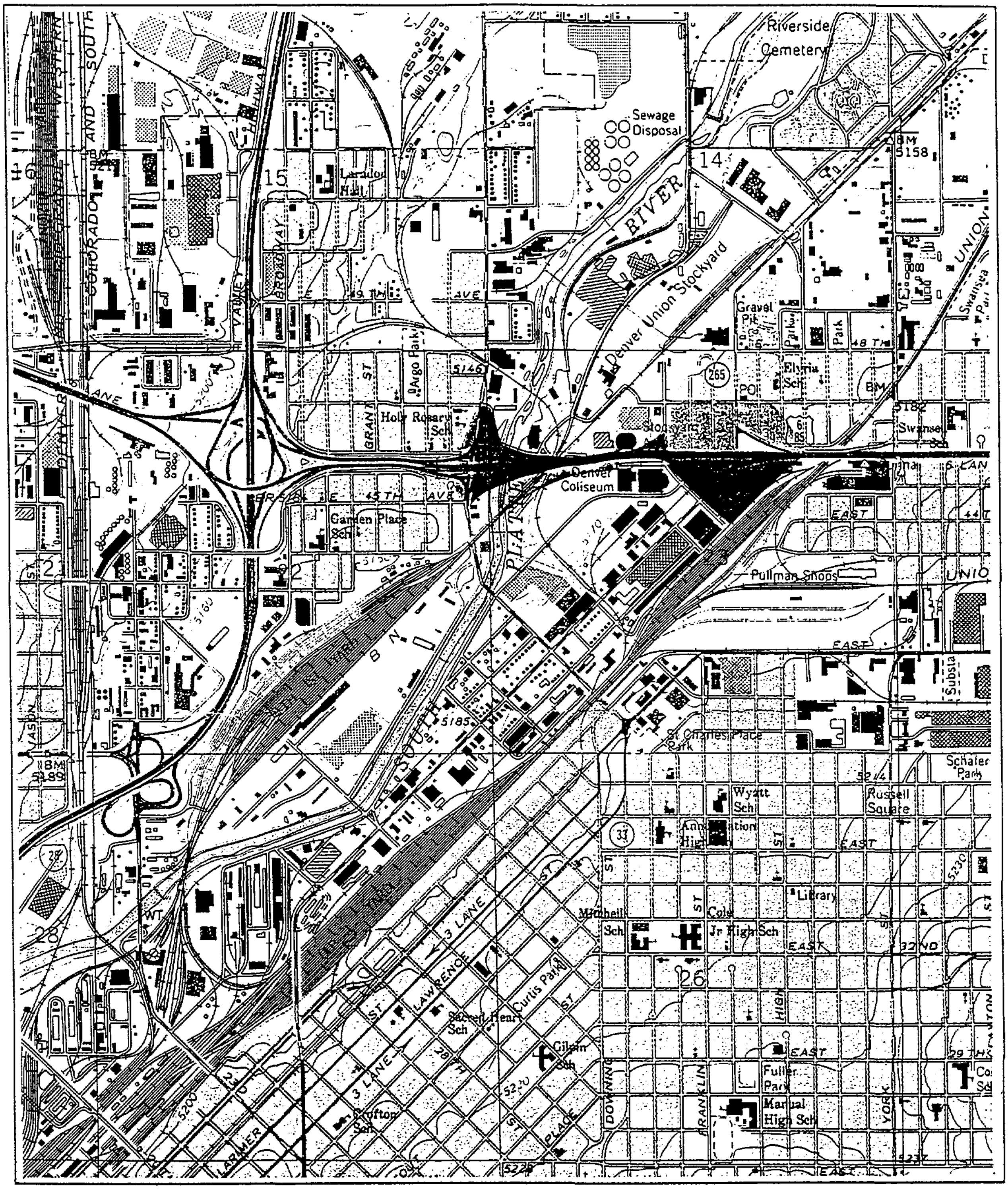


Approximate Map Scale: 1: 24 000

Map Source: USGS Commerce Quadrangle
Colorado, 7.5 Min. Series (topographic) 1959
Photorevised 1980

Blue = Phase I
Green = Phase II
Yellow = Phase III

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Vicinity Map

| Job 3008-020 | Date 4/98 | Figure 1 |
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# 2 CONSTRUCTION

The CDOT plans to replace the elevated portion of I-70 from Washington Street to Brighton Boulevard with a wider, elevated highway (see Figure 2). Existing ramps at Humboldt Street will be removed and replaced with interchanges constructed at North Washington Street and Brighton Boulevard. The existing elevated structure east of Humboldt Street will be replaced, and fill material will be used to support I-70 east of Humboldt Street. A pedestrian underpass is proposed to connect the Denver Coliseum and National Western Stock Show buildings. This underpass will be constructed beneath the present East 46$^{th}$ Avenue (Figure 2).

Preliminary design plans indicate that property acquisition will be required for the widening of I-70, the relocations of East 46th Avenue and Brighton Boulevard. The Union Pacific Railroad (UPRR) tracks (south of I-70 at Brighton Boulevard) will be moved southward to accommodate proposed ramp structures. Demolition of existing structures, construction of the Denver Coliseum/National Western Stock Show pedestrian underpass, retaining walls, caissons, storm/sanitary sewers, and other utility relocations will require excavation at various locations in the project area.

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# 3 SITE ENVIRONMENTAL CONDITIONS

Phase II and III of the modifications to I-70 between Humboldt/44th Streets and Brighton Boulevard traverse a commercial, industrial and residential area where several environmental concerns have been identified (Figure 6). Properties of concern were identified along East 46th Avenue and Brighton Boulevard in 1991 (WALSH, 1991a), including eleven properties with known USTs. This study was expanded in July 1991 (WALSH, 1991b, 1992) to include the I-70 corridor from North Washington Street to Brighton Boulevard and was revised in late 1996 (WALSH, 1996).

These reports identified four main categories of environmental concern: petroleum contaminated soils and ground water from leaking USTs; possible soil and ground water contamination from tannery operations; soil contaminated with smelter wastes or other materials resulting in elevated heavy metal content; and ground water contaminated with low concentrations of chlorinated hydrocarbons. The recently completed Phase II and III Construction Site Investigation (WALSH, 1998c) confirmed the presence of petroleum contaminated soils and ground water from leaking USTs, widespread chlorinated solvent contamination of ground water, and soil contaminated with smelter wastes, polycyclic aromatic hydrocarbons (PAHs) and oil.

The planned construction activities will occur south of East 47th Avenue from Humboldt Street to Brighton Boulevard, along and south of East 46th Avenue from 44th Street to Brighton Boulevard, along 44th Street to Brighton Boulevard, and along Brighton Boulevard from 44th Street to East 47th Avenue. The construction activities will involve numerous residential and commercial properties.

The planned pedestrian underpass beneath East 46th Avenue will connect the Denver Coliseum and the National Western Stock Show buildings. Excavation for this underpass will occur adjacent to an area in which smelter wastes were utilized as fill materials. This fill contains metals above the regional norms, but is not a hazardous waste.

## 3.1 Phase II Construction Area

The widening of 44th Street and Brighton Boulevard, the expansion of I-70 and the relocation of the UPRR tracks will involve several parcels which are contaminated with petroleum products, heavy metals and chlorinated solvents. Intrusive activities include the demolition of buildings on sites with known petroleum and heavy metal soil contamination, past usage as gasoline service stations, or a history of storage of bulk petroleum products. Excavations will also be required for the relocation of utilities, including sanitary and storm sewers, the relocation of the UPRR tracks, the widening of Brighton Boulevard and 44th Street, and excavations for support pier and the foundations of retaining walls. Most excavations will not encounter ground water which is found at depths in excess of 27 feet (Figure 4).

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### 3.1.1 Land Use in the Phase II and III Construction Areas

Land use along I-70 between Humboldt Street and Brighton Boulevard is mainly commercial and light industrial. Residences predominate in the Phase III construction area in neighborhoods not bounded by East 46th Avenue or Brighton Boulevard. Commercial enterprises include a lumberyard, automobile repair and parts retailers, commercial warehouses, and equipment repair shops. Denver Fire Station #9 occupies the northeast corner of Franklin Street and East 46th Avenue. Formerly, service stations were located near the intersection of Humboldt and 44th Street, East 46th Avenue and Brighton Boulevard, and 44th street and Brighton Boulevard. Bulk petroleum products were also formerly stored on Parcel 50 (site of Western Boom). Most of the area south of I-70, between the South Platte River and Humboldt Avenue, is now occupied by the grounds of the Denver Coliseum.

The area now covered by the paved parking lots of the Coliseum was once the site of an extensive sand and gravel quarry (1920s) which was subsequently filled with smelter slag and waste rock, and demolition debris from the Omaha and Grant Smelter. In addition, domestic trash was deposited in some of the gravel pit depressions before the area was cleared for parking areas in the late 1940s. Approximately 5 to over 19.5 feet of fill material have been documented under the east bound lane of I-70 (WALSH, 1992 and 1997b, Aguirre, 1995).

### 3.1.2 Petroleum Contaminated Soils and Ground Water

Petroleum contaminated soils are known to exist near East 46th Avenue on Parcel 42 (O G Valentine Lumber). The extent of this contamination is not known, but may extend beneath the building foundations and into East 46th Avenue. Ground water from this site is also contaminated with petroleum and may be contaminated with PCE. See Tables 11, 13, and 14 for supporting data.

Minor petroleum soil contamination was documented on the southeast corner of Parcel 42, and at two sites on Parcel 50 (Western Boom). The limits of the contamination on Parcel 50 is not known, but the parcel has a history of bulk petroleum product storage (Table 6).

Petroleum soil contamination may be found along Parcel 49 (Central Storage) near Brighton Boulevard and under the concrete-covered parking area. The material under the concrete is also contaminated with lead and arsenic. Ground water from TH-15 near the north end of the parcel contains some fuel contamination and may require treatment prior to discharge. The ground water also contains PCE (Tables 6, 8, and 9).

Bulk petroleum was also stored on Parcel 46 (Hydraulic Equipment Repair). Discolored, oily soils on this parcel are also contaminated with lead and arsenic (Table 13).

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### 3.1.3 PCE Contaminated Ground Water

All ground water in the Phase II construction area can be considered contaminated with chlorinated compounds which will require treatment prior to discharge.

PCE is known to occur on six parcels within the construction area. The MCL for PCE was exceeded in ground water samples from Parcel 40 (unpaved parking lot and exit ramp - now under construction), Parcel 42 (O G Valentine Lumber), Parcels 52/53 (Unpaved parking lot and vacant storage lot), Parcel 50 (Western Boom), Parcel 49 (Central Storage), and Parcel 46 (Hydraulic Equipment Repair). The highest concentration of PCE was detected in the ground water from TH-19 on Parcel 49 (140 ppb). 1,1,1-TCA was found on Parcel 46 (Hydraulic Equipment Repair) and DCM, at levels exceeding the MCL, was noted on Parcels 46 and 50 (Western Boom) (Tables 9,11, and 15). Figure 5 shows the latest data and concentrations of VOCs in the study area.

### 3.1.4 Black Fill Material Contaminated with Heavy Metals, Oil, and PAHs

Black-colored fill material was noted on Parcel 46 (Hydraulic Equipment Repair) and Parcel 49 (Central Storage). This fill material contains concentrations of lead and arsenic above the regional and local ranges. The fill also is contaminated with SVOCs (mainly combustion products) and oil (particularly on Parcel 46). The concentration of SVOCs is not considered a significant health or safety risk and the metals are relatively insoluble. This material should be considered a special, not hazardous waste. The extent of this black fill is not known. The source of the hydrocarbons and SVOCs is believed to be from operational practices on the sites; the elevated metal content probably results from the use of smelter waste from the Omaha and Grant Smelter as a fill component (Tables 3, 4, 5, 6, and 7).

## 3.2 Phase III Construction Area

Intrusive activities in the Phase III construction area includes the demolition of existing structures, excavations for utilities and support structures, and construction of the access roads along the north side of I-70. These activities will be occurring in areas of known soil and ground water contamination. The majority of this contamination will be concentrated along the East 46th Avenue/Brighton Boulevard frontage areas.

### 3.2.1 Petroleum Contamination of Soil and Ground Water

Petroleum contamination has been identified on Parcel 79 (Denver Fire Station #9), Parcel 43 (Darko's Automotive), Parcel 99 (Lambert storage building), Parcel 54 (Lambert Auto Parts) and Parcels 55 and 56 (Lambert Automobile Electronics). The extent of the contamination on these sites is not well established. USTs may exist under present buildings and excavation may reveal additional contamination (Tables 6, 10, and 11).

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### 3.2.2 Discolored Soils Containing Heavy Metals and PAHs and/or Oil Contamination

PAH and heavy metal contamination was found in shallow discolored soils on Parcel 99 (Darko's Automotive). The concentration of PAHs do not constitute a serious health and environmental risk and the metals are not characteristically hazardous. This material is a special, not a hazardous waste. The contamination of this material is probably due to operational practices on the site. The contamination may be restricted to the site and to a depth of less than 3 feet (Tables 11, 13, 14).

### 3.2.3 Ground Water Contaminated with PCE (also 1,1,1-TCA and DCM)

Ground water in the Phase III construction area is widely contaminated with PCE and will require treatment prior to discharge. Ground water from Parcel 99 (Lambert storage building) is contaminated with PCE above the Colorado MCLs. The concentration on Parcel 99 was the highest detected in the recent study (530 ppb). PCE and 1,1,1-TCA was also detected in 1991 on Parcel 56 (Lambert parking lot adjoining Lambert Automobile Electronics). Recent data suggests that a large plume of PCE has migrated into the Phase II and III construction areas (Tables 9, 10). Alternatively, several sources of contamination may exist within the work areas. Figure 5 shows the latest data and VOC concentrations in ground water.

The CDOT is concerned that contaminants in the soil and ground water will adversely affect worker health and safety during construction activities.

## 3.3 Site Investigation Activities

WALSH conducted a Site Investigation of the Phase II and III areas in 1998 (WALSH, 1998). Four soil borings were drilled along the route of the 44$^{th}$ Street and Brighton Boulevard expansion and UPRR relocation (Parcels 49 and 50). One test hole was drilled along the route of a proposed storm sewer (Parcel 42). One test hole was drilled down-gradient from a suspected sand trap or unregistered UST and along the route of the west-bound onramp to I-70 (Parcel 99). One test hole was drilled on Parcel 55 along the path of a storm sewer line and in the area affected by the expansion of Brighton Boulevard. This test hole was also down gradient from a possible UST on Parcel 66 or in Brighton Boulevard and cross-gradient to a former UST on Parcel 54.

The test holes were generally sampled to 36.5 feet below the surface, and completed as monitor wells to 35 feet. Depth to ground water in the area ranges from 27 to 31 feet below the surface (Figure 4). Test holes were monitored during drilling for both combustible gases and VOCs using a calibrated GasTech Model 1314 combustible gas indicator (CGI) and a calibrated HNu Model 101 photoionization detector (PID). Sample headspace measurements were taken using the PID to field screen for VOCs. Soil samples were also field screened for elevated concentrations of radioactive elements using a radiation detector. Soil and ground water samples from soil borings and monitor wells were analyzed according to the work plans

(WALSH, 1998a, b). The location of the WALSH test holes from the 1998 study, earlier WALSH investigations, and the Aguirre Engineering geotechnical test holes are shown on Figure 2.

Geoprobe soil borings to 10 feet total depth were drilled at four sites in the Phase II and III construction areas. Three Geoprobe soil sampling sites were located along the southeast side of the Central Storage building on Parcel 49. These samples were collected to determine if former tanning operations in the Central Storage building had affected the metal content of the shallow soils. One area of black metal-bearing fill was identified in GP-4. This location is shown on Figure 2. One Geoprobe soil sample site was placed along the path of the pedestrian underpass in the median strip between the lanes of East 46th Avenue. No smelter waste or other contamination was noted.

### 3.4 Dewatering in Phase II and Phase III Construction Areas

Dewatering may be necessary for highway support piers or retaining wall foundations. Utility excavations will generally not encounter ground water. The Colorado standard for total suspended solids (TSS) and gross alpha and beta radiation was exceeded in the test holes drilled in the Phase II and III construction areas. These results are consistent with discharge parameter testing conducted in other WALSH test holes in the Denver Coliseum area (WALSH, 1997). Table 14 summarizes the discharge parameter results.

### 3.5 Intrusive Activities in Areas Not Screened by the Site Investigation

Should the construction activities be modified to include intrusive activities in areas not evaluated in the Site Investigation, that is, in areas other than shown on Figure 2, a determination of the potential for encountering hazardous materials should be made. This can be accomplished by sampling the areas prior to the actual construction phases, or by taking adequate precautions to have the excavations and materials handling monitored by a qualified environmental professional to identify health and safety and materials management implications.

Contamination may exist under buildings and paved surfaces. These areas of hidden contamination are most likely to occur adjacent to structures which have a history of usage as service stations, bulk petroleum storage sites, dry cleaning establishments, or other commercial enterprises which employed USTs and ASTs. Properties in the Phase II area on which hidden contamination may be expected include: the north side of Parcel 42 (O G Valentine Lumber), Parcel 50 (Western Boom), and Parcel 46 (Hydraulic Equipment Repair). Properties in Phase III on which hidden contamination is likely include: Parcel 79 (Denver Fire Station #9), Parcel 99 (Lambert storage building), Parcels 54 and 55 (Lambert Auto Parts and Automobile Electronics).

The listing of site assessment reports prepared to date are included in the reference section at the end of this report.

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# 4 WASTE IDENTIFICATION AND CHARACTERIZATION

## 4.1 Materials Handling and Screening

All excavations and intrusive construction activities undertaken in the project area will be monitored by an Environmental Specialist (ES) to assist in the identification of the presence of hazardous materials and to ensure that all suspect materials are handled in accordance with the provisions of this plan. The ES will be qualified by education or experience in the identification, characterization, and handling of hazardous materials. The ES will have the authority to stop work in any area if the site conditions are considered to be unsafe, changed from previous estimates, or a threat to contaminate other areas.

The ES will observe all intrusive work in the construction zone and monitor the soils visually to detect the presence of buried containers or grossly contaminated materials, and with the use of a photoionization detector, identify the presence of volatile organic compounds in the soils. If any indication that contaminated materials have been encountered, a determination will be made to halt work until the area can be assessed. Excavated contaminated materials will be stockpiled pending analysis and until they can be characterized and managed according to the guidelines of this plan. This determination will be made based on whether the site conditions are consistent with the information available on that particular location, and the proposed construction activities in that area. The ES will consult with the CDOT Environmental Project Manager to decide on the best course of action for handling the situation and for allowing the work to proceed in this area. Ground water must be treated to conform to the limits set forth in the CDPHE discharge permit.

Once the intrusive activities are completed in a particular area, or if a sufficient area has been screened to determine that no hazardous materials will be encountered during the work in that area, the ES can suspend the site monitoring and allow the contractor to proceed with the work in the area. The contractor will be instructed in methods for determining that hazardous materials have been encountered in areas which do not have a high potential for being impacted, and will be instructed to call the Environmental Project Manager or the ES to inspect the area prior to proceeding.

## 4.2 Suspect Materials Staging and Sampling

WALSH recommends that workers wear gloves as a precautionary measure to minimize contact with the soil. If contaminated soils are encountered (visible contamination, odor, PID readings), then the soils should be stockpiled. The staging areas will allow for the safe storage and sampling of the soils which are suspected to be contaminated. The staging areas will be located in areas selected by the Contractor in consultation with CDOT. These areas will be lined with 6 mil plastic and covered with plastic sheeting at the conclusion of each work day. The cover will ensure that no runoff will occur from the waste materials into surface waters during rain events. A berm will be created around the staging areas to prevent any runoff from the surface soils from impacting areas outside of the impoundment and to prevent surface waters from entering the site during rain events. Materials will only be kept at this location for the time required to analyze, and determine the proper handling procedures.

Once suspect materials have been moved to the staging area, representative samples will be collected for laboratory analysis by the ES. Stockpiled soils from Parcel 49 (Central Storage), Parcel 43 (Darko's Automotive), and Parcel 46 (Hydraulic Equipment Repair) will be tested for total RCRA metals and TEPH using composting techniques to ensure representative sampling. A small amount of material will be collected from a large number of locations and placed into a clean stainless steel bowl. The composite sample will be well mixed and transferred to individual sample jars for transportation to the laboratory.

Stockpiled soils from Parcels 42, 79, 54, 55, and 56 will be tested for TEPH and possibly BTEX. Sampling will be conducted as explained above.

The number of samples collected from each material stockpiled depends on the types of material, the homogeneity of the material, and the total amount of soils identified. For example, if soils are excavated from an area previously identified as being contaminated with only petroleum hydrocarbons, a minimum of one sample is required for each 1000 cubic yards of material sent for disposal. Disposal facilities may have additional sampling requirements. These facilities will inform the contractor of sampling frequencies before any material is accepted. A higher sampling frequency may be required of unknown materials for which no previous data is available.

Ground water in the Phase II and III area exceeds CGWSs for TSS and must undergo treatment prior to discharge. PCE contamination is widespread in the construction area. Ground water may require treatment to remove PCE, 1,1,1-TCA, and methylene chloride before discharge. The ground water is also contaminated in several areas with petroleum hydrocarbons. Sampling parameters and testing frequency will be specified in the ground water discharge permit issued by the CDPHE.

### 4.3 Laboratory Analysis

Composite soil samples will be analyzed for total RCRA metals by EPA Method 6020A at a qualified laboratory. Discolored fill materials from the study area are known to contain low concentrations of PAHs which are likely the combustion by-products of coal. These compounds are unregulated at the concentrations detected in the samples. In WALSH's opinion, further testing for SVOCs will supply little additional information and is unnecessary. Samples collected for waste characterization will be analyzed using standard EPA methodology appropriate for the type of material. Samples for materials which may require disposal or samples for the identification of unknown materials should be analyzed using EPA SW-846 methods for the characterization of waste and the identification of hazardous wastes.

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Petroleum contamination is known to occur in the area. Stockpiled soils should be analyzed using methodologies identified by the Colorado Department of Public Health and the Environment Underground Storage Tank Division. The primary analysis would be Total Extractable Petroleum Hydrocarbons (TEPH). In WALSH's opinion, Total Volatile Petroleum Hydrocarbons (TVPH), Benzene, Toluene, Ethylbenzene, Xylenes (BTEX), Methyl tert-butyl ether (MTBE), and Oil and Grease are optional analyses.

Samples contaminated with petroleum hydrocarbons from underground storage tanks (known to occur along East 46th Avenue between Franklin and Brighton Boulevard, and near the corner of Brighton Boulevard and East 46th Avenue) which exceed the site action level (RAC-II 250 mg/Kg) will also require characterization analyses for disposal criteria. These analyses include: ignitability; TCLP metals; paint filter; and total petroleum hydrocarbons.

Petroleum contamination may also occur in the soils excavated from Parcels 46 and 50. This contamination is believed to the result of leakage from bulk petroleum products stored on the sites. The petroleum contamination in Parcel 46 is mainly oil and grease, but samples exceeding RAC II TEPH levels should be tested for total metals and RCRA characteristics for disposal purposes. Oil and solvent contamination may be encountered in soils on Parcels 55 and 56 (Lambert Automobile Electronics and parking lot), particularly when demolition of the building is commenced and the hydraulic oil USTs are removed.

The actual set of analyses for which each sample will be analyzed depends on the information available on the source of the chemicals, the preferred method of handling, and the amount of the material, therefore it is not possible to list all of the possibilities in this document. All field decisions regarding the proposed remedial action and the analysis of the samples will be documented separately to the project engineer as soon as this data is available on the project.

## 4.4 Soil Designation and Disposal Criteria

The disposition of suspect materials encountered on this project will be performed in accordance with applicable waste management guidelines where appropriate or by the standards included in this document for those chemicals for which there are no standards. The source of these standards is the Environmental Protection Agency in the Hazardous Waste Regulations (40 CFR 261), the Colorado Department of Public Health and Environment for the underground storage tank regulations, CDPHE for drinking and surface water standards, and other sources.

The first approach to defining the regulatory category in which each of the waste materials would be identified is to determine if the wastes are due to a listed waste. If the material is a listed waste based on the source which created the waste, it may be considered to be an EPA hazardous waste. If a determination cannot be made as to the classification of the source, the materials will be tested for its classification as a characteristic waste. Hazardous wastes are characteristic according to analysis of TCLP extraction and analysis of volatile and semi-volatile organic compounds, and metals. If a particular material does not meet the criteria of a listed or a characteristic waste, the presence of certain concentrations of other chemicals may still warrant the classification of the wastes as hazardous. In some cases, this determination can be made with consultation with the USEPA or the CDPHE.

Table 1 lists the soil classification criteria for solid waste materials encountered on this project based on the concentrations of particular contaminants detected in soil samples. The analytical results will be compared to the individual analytes on the table to identify the classification of the materials. Soils classified in the various categories will then be handled according to the materials management guidelines in Section 5.

# 5 DISPOSITION OF CONTAMINATED MATERIALS

The following section identifies the options available for the disposition of suspect materials characterized in the various categories based on the laboratory analysis performed and the results based on a comparison to the categories in Table 1. In addition, specific guidelines and procedures are detailed for work in specific areas of the project.

## 5.1 Petroleum Contaminated Materials and Special Wastes

The results of the Site Investigation (SI) (WALSH, 1991b, 1992, 1998c) suggest that there is a high probability of encountering petroleum contaminated soils in the course of this project. Based on the proximity to ground water, the remedial action category (RAC) most likely specified for this area is RAC II. This category is moderately stringent and specifies that soils in excess of 250 mg/Kg of total petroleum hydrocarbons or 50 mg/Kg of BTEX in soils be removed when encountered and not replaced in the ground.

Soils with petroleum hydrocarbons present in concentrations below the RAC II level may technically be used without restriction on the project, but appropriate locations should be identified to minimize the impact to surface and ground water for soils with significant petroleum concentrations below this RAC level.

Special Wastes are identified as wastes from industrial operations or remediation of these wastes which are high enough in concentration to pose a potential health threat in uncontrolled locations, but are not high enough in concentration to be considered as hazardous wastes. These materials must be transported to an appropriate disposal facility permitted to receive the specific materials.

The SI (WALSH, 1998c) and previous studies (WALSH, 1991b, 1992, 1996) identified a discolored (black) fill material in the vicinity of the Denver Coliseum parking lot which contained elevated concentrations of heavy metals (zinc, copper, lead, and mercury), low concentrations of SVOCs, and relatively minor petroleum contamination. Similar material has been found on Parcel 49 (Central Storage) and Parcel 46 (Hydraulic Equipment Repair). Black fill material containing elevated concentrations of metals and some petroleum contamination was also found on Parcel 43 (Darko's Automotive). Segregation and stockpiling of potentially or visibly contaminated soils is discussed in Section 4.2. Tables summarizing the analytical results for the

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soil and ground water samples from the 1991 and 1998 site investigations are presented in the Table Section at the conclusion of this report.

## 5.2 Hazardous Wastes

The potential exists that materials which may be classified as hazardous waste will be encountered on this project. If stockpiled materials are identified as hazardous wastes, the materials will be containerized in drums or in rolloff bins and covered immediately to prevent personnel exposure to these materials and to prevent contamination of other materials. The hazardous waste shall be labeled and provisions should be made as quickly as possible for having the material approved for disposal at an approved hazardous waste disposal facility. These wastes will then be manifested and transported to the disposal facility in accordance with state and federal regulations by appropriately licensed, certified, and insured transporters.

Disposal of hazardous wastes will require that the generator obtain a hazardous waste generators permit. If the generator does not have a permit already, a one-time notification permit can be obtained from the CDPHE Hazardous Materials Division once these materials are identified.

## 5.3 Ground Water

Ground water in the Phase II and III construction areas exceeds Colorado drinking water standards for several chlorinated compounds, particularly PCE and DCM. In addition, the ground water exceeds CGWSs for TSS and in places contaminated with petroleum hydrocarbons. The ground water must undergo treatment prior to discharge. PCE and other solvents, may be removed from ground water by air stripping, which will also remove volatile petroleum hydrocarbons. Diesel-range hydrocarbons and oils can be treated by bioreaction or through carbon filtration. DCM that is not removed through air stripping will be removed during carbon filtration. Settling or flocculation of the ground water either before air stripping will remove excessive TSS and will reduce radiation levels. Exact treatment techniques will be dictated by the conditions of the CDPHE discharge permit.

The sludge/flocculate in the settling pond or tank and the carbon filters will require testing prior to disposal. The material should be tested for SVOCs, TEPH, total metals, and VOCs. Results of the testing will determine if the material is suitable for reburial (sludge) or disposal offsite as a special or hazardous waste.

Ground water is found at depths exceeding 27 feet in the project area and most excavations will not encounter ground water. The ground water flow direction is shown on Figure 3. Ground water flows tot he northwest, towards the South Platte River. Depth to ground water is depicted on Figure 4. Depth to ground water in the individual test holes drilled in the construction areas is summarized on Table 2.

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Handling of the ground water must be performed in a manner which minimizes worker contact and the impact to nearby soil and water resources. The following approach is suggested to minimize contact with the ground water: dewatering of excavations and temporary storage of the water in oil field frac tanks or lined settling ponds. The water can then be removed to a treatment area or treated onsite and then discharged to the sewer system if analyses indicate that the water conforms to the CDPHE-issued discharge permit.

Infiltration ponds for the water may not be feasible due to the widespread PCE contamination. However, aeration of the ground water in ponds may eliminate most of the solvent contamination.

If CDOT must discharge this ground water, then a discharge permit must be obtained from the CDPHE. The permit will specify treatment standards and testing requirements for the treated effluent.

TSS, metals, and natural radiation are reduced through settling and/or flocculation. SVOCs and petroleum contamination are most readily removed from the waste stream through absorption onto activated carbon. As mentioned above, air stripping effectively removes PCE. One possible treatment scenario is as follows: pump the ground water into a series of oil field frac tanks to which a flocculant can be added; the clearer water can then be drawn off and filtered to remove any remaining silt and clay and subsequently passed through an air stripper and a series of activated carbon canisters. The treated effluent must be analyzed to confirm the efficacy of the treatment process.

A second treatment possibility is ultraviolet/oxidation treatment in which the filtered water is exposed to intense ultraviolet radiation in the presence of an oxidizing agent, usually hydrogen peroxide. This process generates highly reactive hydroxyl radicals that react with and destroy most organic chemical compounds. If destruction is complete, the final products are carbon dioxide, water, and salts. This treatment system is available in enclosed semi-trailers which could be placed near the site. Holding tanks (frac tanks) would also be required.

## 5.4 Tank Bottom Sludge and Carbon Canisters

Some contaminated materials will be generated by ground water treatment. Silt and clay in the settling ponds/frac tanks should be analyzed to determine if it is contaminated with metals, petroleum hydrocarbons and possibly SVOCs. The concentrations of the metals (and the TCLP results) will determine whether the material can be disposed of as special or hazardous waste. If carbon absorption is used as a treatment process for the ground water, then the spent filters and carbon canisters must be disposed of in an appropriate manner. The supplier of the carbon canister may include this service in the price of the canisters. More likely, CDOT will have to dispose of these materials as a special or hazardous waste.

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# 6 EMERGENCY RESPONSE PROVISIONS

In order to protect workers from the hazards presented by the contaminants present in the Phase II and III construction areas, a site-specific project Health and Safety Plan (HASP) has been prepared for all construction activities. The HASP outlines safety procedures to be followed by all site personnel. The safety procedures in contaminated areas are often initially stringent, requiring the continuous monitoring of ambient air for VOCs, explosive gasses, and radiation. Subsequent to the Site Investigation by WALSH (1998c), these monitoring provisions have been relaxed. Construction personnel need to avoid contact with the ground water and discolored soils. Construction personnel should remain alert to the possibility that undetected contamination may be uncovered during demolition activities and installation of utilities and road modifications. If contaminated soils are discovered, then a qualified environmental professional will oversee the proper stockpiling, sampling and disposal of the soil. Additional safety measures may also be implemented. All personnel working on this project are required to be familiar with the site HASP and sign that they have reviewed it.

As a part of this health and safety program, an emergency response plan (ERP) has been prepared. This ERP identifies several procedures which will be in place to handle foreseeable emergencies. The types of emergencies which may impact the project activities and the environmental conditions would include: encountering of drums, tanks, or other buried chemical containers, or previously undetected soil contamination.

D 01049

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D 01051

# TABLES

D 01052

## Table 1 SOILS DESIGNATION AND DISPOSAL CRITERIA

| Analytical Results | "Uncontaminated" | "Contaminated"[6] | "Hazardous Waste" |
|---|---|---|---|
| Total BTEX | 0 to 50 mg/kg | >50 mg/kg[5*] | 40 Code of Federal Regulations Part 261 (Identified as having hazardous waste characteristics, is a listed waste, or fails TCLP limitations.) |
| TEPH | 0 to 250 mg/kg | > 250 mg/kg[5] | |
| Semivolatile Organic Compounds[8] | 0 mg/kg | >0 mg/kg[7] | Listed wastes |
| Volatile Organic Compounds | < 20x MCL for Selected VOCs[4] | > 20x MCL for selected VOCs[4] | Listed wastes or > TCLP limit for certain VOCs |
| Arsenic | 0 to 50 mg/kg | > 50 mg/kg[1] | > 5 mg/L TCLP |
| Barium | 0 to 1,000 mg/kg | > 1,000 mg/kg[1] | > 100 mg/L TCLP |
| Cadmium | 0 to 35 mg/kg | > 35 mg/kg[2] | > 1 mg/L TCLP |
| Chromium | 0 to 365 mg/kg | > 365 mg/kg[2] | > 5 mg/L TCLP |
| Lead | 0 to 500 mg/kg | > 500 mg/kg[3] | > 5 mg/L TCLP |
| Mercury | 0 to 15 mg/kg | > 15 mg/kg[2] | > 0.2 mg/L TCLP |
| Selenium | 0 to 10 mg/kg | > 10 mg/kg[1] | > 1 mg/L TCLP |
| Silver | 0 to 50 mg/kg | > 50 mg/kg[1] | > 5 mg/L TCLP |
| **Disposal Method** | **On-site - if appropriate locations are available** | **Off-site: Solid Waste Disposal Facility** | **Off-site: Hazardous Waste Disposal Facility** |

1 Upper level is 10 times the TCLP limit
2 California Department of Health Services Total Threshold Limit Concentration (California Administration Code, 1985)
3 Office of Solid Waste Emergency Response Directive (EPA, 1989; 1991)
4 Proposed action levels previously presented to CDH and EPA (WCC, 1991), (regulated VOCs concentrations limited to 20 X state Ground Water Standard (5 Colorado Code of Regulations 1002-8).
5 Remedial Action Category II (CDH, 1991), (for non-UST sources benzene limited to TCLP standard of 0.5 mg/l)
6 All "contaminated" waste with total concentrations greater than 20 X TCLP limits will be analyzed by TCLP methods for hazardous waste determination
7 Concentration dependent on species and risk-based analysis
8 Listed Compounds Only

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## Table 2 Depth to Groundwater (Feet)

| Location | Depth to Ground Water Below T.O.C. | Elevation of Casing | Elevation of Surface | Ground Water Elevation |
|---|---|---|---|---|
| **WALSH Test Holes May 1998 [A]** | | | | |
| TH-19 | 29.65 | 5187.27 | | 5157.62 |
| TH-20 | 29.81 | 5187.41 | | 5157.60 |
| TH-21 | 30.16 | 5187.63 | | 5157.47 |
| TH-22 | 30.18 | 5187.50 | | 5157.32 |
| TH-23 | 29.23 | 5185.71 | | 5156.48 |
| TH-24 | 29.42 | 5185.11 | | 5155.69 |
| TH-25 | 28.96 | 5184.98 | | 5156.02 |
| **WALSH Test Holes June 1997 [G]** | | | | |
| DC-2 | 15.14 | 5168.25 | 5168.45 | 5153.11 |
| DC-3 | 10.02 | 5163.72 | 5163.99 | 5153.70 |
| DC-4 | 9.09 | 5162.00 | 5162.32 | 5152.91 |
| **WALSH Test Holes 1991 [B]** | | | | |
| TH-1 | 17.37 | 5170.08 | 5170.29 | 5152.71 |
| TH-2 | 12.62 | 5163.41 | 5163.74 | 5150.79 |
| TH-3 | 9.87<br>10.10 [C] | 5160.09 | 5160.26 | 5150.22<br>5149.99 |
| TH-4 | 11.48 | 5158.47 | 5158.72 | 5146.99 |
| TH-5 | 18.08 | 5152.01 | 5150.28 | 5133.93 |
| TH-6 | 28.80 | 5184.31 | 5183.12 | 5155.51 |
| TH-7 | 26.88 [F] | 5180.78 | 5181.17 | 5153.90 |
| TH-8 | 28.82 | 5181.78 | 5182.03 | 5152.96 |
| TH-9 | 29.03 | 5182.96 | 5183.13 | 5153.93 |
| TH-10 | 27.09<br>28.23 [H] | 5181.24 | 5181.48 | 5154.15<br>5153.01 |
| TH-11 | 27.87 | 5181.56 | 5181.85 | 5153.69 |
| TH-12 | 27.68 | 5181.62 | 5181.93 | 5153.94 |
| TH-13 | 27.46 | 5181.83 | 5182.18 | 5154.37 |
| TH-14 | 27.03 [F] | 5181.00 | 5181.37 | 5153.97 |
| TH-15 | 26.66 | 5182.54 | 5182.95 | 5155.88 |
| TH-16 | 28.62<br>29.95 [H] | 5184.50 | 5184.71 | 5155.88<br>5154.55 |
| TH-18 | 28.05<br>29.10 [J] | 5183.24 | 5183.65 | 5155.19<br>5154.14 |
| **Aguirre Piezometers 1992-1994 [D]** | | | | |
| BW-1 | (6.1) 20.0 | | (1568.5) 5144.7 | 5124.7 |
| BW-5 | (9.8) 32.1 | | (1572.0) 5156.2 | 5124.1 |
| BW-10 | (7.6) 24.9 | | (1574.6) 5164.7 | 5139.8 |
| BW-13 | (11.9) 39.0 | | (1579.4) 5180.4 | 5141.4 |
| BW-18 | (10.7) 35.1 | | (1580.0) 5182.4 | 5147.3 |
| THW-29 | (13.1) 43.0 | | (1579.2) 5179.8 | 5136.8 |

D 01054

| Table 2 (Cont'd) Depth to Groundwater (Feet) | | | | |
|---|---|---|---|---|
| Location | Depth to Ground Water | Elevation of Casing | Elevation of Surface | Ground Water Elevation |
| Aguirre Soil Borings[E] 1992 | | | | |
| B-2 | (7.6) 24.9 | | (1569.6) 5148.3 | 5123.4 |
| B-3 | (2.2) 7.2 | | (1566.3) 5137.5 | 5130.3 |
| B-4 | (7.3) 23.9 | | (1571.9) 5155.8 | 5131.9 |
| B-6 | — | | (1570.6) 5151.6 | — |
| B-7 | (13.4) 44.0 | | (1572.6) 5158.1 | 5114.1 |
| B-8 | (12.9) 42.3 | | (1572.6) 5158.1 | 5115.8 |
| B-9 | (8.8) 28.9 | | (1573.7) 5161.7 | 5132.8 |
| B-11 | (9.1) 29.8 | | (1579.4) 5180.4 | 5150.6 |
| B-12 | (8.8) 28.9 | | (1579.6) 5181.1 | 5152.2 |
| B-14 | (8.6) 28.2 | | (1579.4) 5180.4 | 5152.2 |
| B-15 | (8.4) 27.6 | | (1579.4) 5180.4 | 5152.8 |
| B-16 | (8.4) 27.6 | | (1579.1) 5179.4 | 5151.8 |
| B-17 | (8.4) 27.6 | | (1579.7) 5181.4 | 5153.8 |
| B-19 | (8.3) 27.2 | | (1579.9) 5182.1 | 5154.9 |
| Aguirre Test Holes[E] 1994 | | | | |
| TH-1 | (6.0) 19.6 | | (1569.7) 5148.6 | 5129.0 |
| TH-2 | (4.0) 13.1 | | (1569.4) 5147.6 | 5134.5 |
| TH-3 | (1.3) 4.1 | | (1566.0) 5136.5 | 5132.4 |
| TH-4 | (7.0) 23.0 | | (1571.7) 5155.2 | 5132.2 |
| TH-5 | (6.4) 20.9 | | (1571.8) 5155.5 | 5134.6 |
| TH-6 | — | | (1571.1) 5153.2 | — |
| TH-7 | (5.5) 18.0 | | (1573.3) 5160.4 | 5142.4 |
| TH-8 | (3.6) 11.8 | | (1572.7) 5158.5 | 5146.7 |
| TH-9 | (5.2) 16.9 | | (1572.5) 5157.8 | 5140.9 |
| TH-10 | (3.9) 12.8 | | (1572.5) 5157.8 | 5145.0 |
| TH-11 | (3.6) 11.9 | | (1572.6) 5158.1 | 5146.2 |
| TH-12 | (3.9) 12.8 | | (1572.5) 5157.8 | 5145.0 |
| TH-13 | (3.3) 10.8 | | (1573.2) 5160.1 | 5149.3 |
| TH-14 | (3.9) 12.8 | | (1574.2) 5163.4 | 5150.6 |
| TH-15 | (5.2) 16.9 | | (1574.8) 5165.3 | 5148.4 |
| TH-16 | (6.7) 21.9 | | (1576.1) 5169.6 | 5147.7 |
| TH-17 | (8.2) 27.0 | | (1578.2) 5176.5 | 5149.5 |
| TH-18 | (9.4) 30.8 | | (1579.6) 5181.1 | 5150.3 |
| TH-19 | (10.8) 35.4 | | (1579.5) 5180.8 | 5145.4 |
| TH-20 | (12.5) 41.0 | | (1579.3) 5180.1 | 5139.1 |
| TH-21 | (9.3) 30.5 | | (1579.9) 5182.1 | 5151.6 |
| TH-22 | (8.8) 28.9 | | (1579.8) 5181.7 | 5152.8 |
| TH-23 | (9.6) 31.5 | | (1579.3) 5180.1 | 5148.6 |
| TH-24 | (8.4) 27.6 | | (1579.5) 5180.8 | 5153.2 |
| TH-25 | (8.4) 27.6 | | (1579.6) 5181.1 | 5153.5 |

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| Table 2 (Cont'd) Depth to Groundwater (Feet) | | | | |
|---|---|---|---|---|
| Location | Depth to Ground Water | Elevation of Casing | Elevation of Surface | Ground Water Elevation |
| TH-26 | (8.8) 28.9 | | (1579.8) 5181.7 | 5152.8 |
| TH-27 | (8.5) 27.9 | | (1579.8) 5181.7 | 5153.8 |
| TH-28 | (7.9) 25.9 | | (1579.3) 5180.1 | 5154.2 |
| TH-30 | (7.9) 25.9 | | (1579.4) 5180.4 | 5154.5 |

[A] = Test holes drilled May 1998. Water levels measured on May 26, 1998. Measurements in feet.
[B] = Water levels measured February 13, 1992. Measurements in feet.
[C] = Water level measured on June 5, 1997. Measurement in feet.
[D] = Water measurements latest available - January 31, 1995. Measurements in parentheses meters.
[E] = Water levels probably not stabilized at time of measurement.
[F] = Water level measurements from April 9, 1991.
[G] = Water level measurements from June 5, 1997.
[H] = Water level measurement from May 26, 1998.
[J] = Water level measurement from May 5, 1998.
T.O.C. = Top of Casing

D 01056

# Table 3 Soil Concentrations of Metals (mg/Kg) and Typical Local and Regional Ranges - Humboldt/44TH Streets to Brighton Boulevard (WALSH 1998 Test Holes)

| Metal | CDOT Mean[1] | CDOT Range | Western U.S. Range[2] | U.S. Typical Range[3] | TH-19 | TH-20 | TH-21 | TH-22 | TH-23 | TH-24 | TH-25 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Arsenic | 5.5 | ND[5]-13 | 0.1-40 | 1-40 | 7.6 | 7.1 | ND | ND | 6.4 | 11 | 6.9 |
| Barium | 563 | 13-1000 | 100-3000 | 100-3000 | 100 | 53 | 24 | 29 | 33 | 150 | 62 |
| Cadmium | 1.83 | ND-6 | 0.01-2 | 0.01-7 | ND | ND | ND | ND | ND | ND | ND |
| Chromium | 12.5 | ND-14 | 5-1500 | 5-3000 | 8.7 | 5.7 | 2.5 | 3.2 | 3.9 | 12 | 5.8 |
| Lead | 33 | 1.8-80 | 2-300 | 2-200 | 7.3 | ND | ND | 5.6 | ND | 32 | 53 |
| Mercury | <DL[4]-(0.1) | ND-0.2 | 0.01-0.055 | 0.01-0.08 | ND | ND | ND | ND | ND | 0.13 | ND |
| Selenium | <DL-(10) | ND-2 | 0.01-12 | 0.1-2 | ND | ND | ND | ND | ND | ND | ND |
| Silver | <DL-(1) | ND-1 | 0.01-8 | 0.1-5 | ND | ND | ND | ND | ND | ND | ND |

(1) Calculated from 71 soil samples collected from CDOT projects in the Denver Metro Area.
(2) Bowen, 1979
(3) Dragun, 1988
(4) Detection Limit
(5) Not Detected
Bold numbers exceed U.S. Typical Ranges or local CDOT ranges for a particular metal.

D 01057

## Table 4 Soil Concentrations of Metals (mg/Kg) and Typical Local and Regional Ranges – Humboldt/44TH Streets to Brighton Boulevard (WALSH 1998 GeoProbe Soil Samples)

| Metal | CDOT Mean[1] | CDOT Range | Western U.S. Range[2] | U.S. Typical Range[3] | Location and Sample Depth (Feet) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | GP-1 (1.9-2.9) black fill | GP-1 (1.9-10.0) bl. Fill excl. | GP-2 (3-10) | GP-3 (4-10) | GP-4 (2.5-10.0) |
| Arsenic | 5.5 | ND[5]-13 | 0.1-40 | 1-40 | 93 (ND) | 6.3 | ND | ND | ND |
| Barium | 563 | 13-1000 | 100-3000 | 100-3000 | 800 | 70 | 4.7 | 24 | 12 |
| Cadmium | 1.83 | ND-6 | 0.01-2 | 0.01-7 | 3.1 | ND | ND | ND | ND |
| Chromium | 12.5 | ND-14 | 5-1500 | 5-3000 | 10 | 7.1 | ND | 2.0 | 1.8 |
| Lead | 33 | 1.8-80 | 2-300 | 2-200 | **970** (0.24) | ND | ND | ND | ND |
| Mercury | <DL[4]-(0.1) | ND-0.2 | 0.01-0.055 | 0.01-0.08 | ND | ND | ND | ND | ND |
| Selenium | <DL-(10) | ND-2 | 0.01-12 | 0.1-2 | ND | ND | ND | ND | ND |
| Silver | <DL-(1) | ND-1 | 0.01-8 | 0.1-5 | 4.3 | ND | ND | ND | ND |

(5) Calculated from 71 soil samples collected from CDOT projects in the Denver Metro Area.
(2) Bowen, 1979
(3) Dragun, 1988
(4) Detection Limit
(5) Not Detected
Bold numbers exceed U.S. Typical Ranges or local CDOT ranges for a particular metal.
TCLP results in parentheses.

## Table 5 SVOCs in Soils (ug/Kg) - Humboldt/44TH Streets to Brighton Boulevard

| Compound | Location | | | | | | |
|---|---|---|---|---|---|---|---|
| | TH-19 | TH-20 | TH-21 | TH-22 | TH-23 | TH-24 | GP-4 |
| Benzo[a]pyrene | ND | ND | ND | ND | ND | 330 | ND |
| Benzo[b]fluoranthene | ND | ND | ND | ND | ND | 330 | ND |
| 2,6-Dinitrotoluene | 500 | ND | ND | ND | ND | ND | ND |
| Fluoranthene | ND | ND | ND | ND | ND | 510 | ND |
| Pyrene | ND | ND | ND | ND | ND | 580 | ND |
| Unknown Multi-ringed Aromatic | ND | ND | ND | ND | ND | 170 T | ND |
| Sulfur, Molecular | ND | 1,900 T | ND | ND | ND | ND | ND |

Concentrations in ug/Kg (parts per billion).
ND = not detected
T = Tentatively Identified Compound by mass spectrum

D 01058

# Table 6 Concentration of Petroleum Hydrocarbons in Soil (ug/Kg) - Humboldt/44TH Streets to Brighton Boulevard, WALSH 1998 Test Holes

| | Location and Depth (Feet) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Analyte | TH-19 (5-6.5) | TH-19 (30-31.5) | TH-20 (30-31.5) | TH-20 (35-36.5) | TH-21 (5-6.5) | TH-21 (30-31.5) | TH-22 (10-11.5) | TH-22 (30-31.5) | TH-23 (5-6.5) | TH-23 (30-31.5) | TH-24 (5-6.5) | TH-24 (25-31.5) | TH-25 (5-6.5) | TH-25 (25-31.5) |
| Benzene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Toluene | ND | 12 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 18 | ND |
| Ethylbenzene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 6.1 | ND |
| Total Xylenes | ND | 5.6 | ND | ND | ND | 340 | ND | 5.1 | ND | ND | ND | ND | 34 | ND |
| BTEX | ND | 17.6 | ND | ND | ND | 340 | ND | 5.1 | ND | ND | ND | ND | 58.1 | ND |
| MTBE | ND | ND | ND | 9.0 | ND | 1,200 | ND | 8.7 | 9.3 | 8.6 | 12 | ND | ND | ND |
| TVPH | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| TEPH | ND | ND | ND | ND | 3,100 | ND | ND | ND | ND | ND | 17,000 | ND | 4,400 | ND |

Bold values exceed Remedial Action Category I (RAC I) standards established by the CDPHE for soils affected by leaking underground storage tanks (USTs) (CDH, 1992).

D 01059

## Table 7 Concentration of Petroleum Hydrocarbons in Soil (ug/Kg) - Geoprobe Soil Samples

| Analyte | Location and Depth (Feet) | | | | |
|---|---|---|---|---|---|
| | GP-1 (1.9-2.9) | GP-1 (1.9-10.0) | GP-2 (3-10) | GP-3 (4-10) | GP-4 (2.5-10.0) |
| **Benzene** | 6.6 J | ND UJ | ND U | ND U | ND U |
| **Toluene** | ND UJ | ND UJ | ND U | ND U | ND U |
| **Ethylbenzene** | 6.3 J | ND UJ | ND U | ND U | ND U |
| **Total Xylenes** | 11 J | ND UJ | ND U | ND U | ND U |
| **BTEX** | 23.9 | ND | ND | ND | ND |
| **MTBE** | 94 J | 48 J | ND U | ND U | ND U |
| **TVPH** | ND UJ | ND UJ | ND U | ND U | ND U |
| **TEPH** | 13,000 | ND U | ND U | ND U | ND U |

ND = Not Detected
U = Compound was searched for but not detected at or above the method detection limit.
J = Compound was identified out of the method working limits and should be considered an estimated value.

## Table 8 Volatile Organic Compounds in Ground Water (ug/L), 1998 WALSH Test Holes

| Compound | TH-19 | TH-20 | TH-21 | TH-22 | TH-23 | TH-24 |
|---|---|---|---|---|---|---|
| Tetrachloroethene | **140** | **8.1** | **7.8** | **19** | **31** | **530** |
| Methylene Chloride | ND | ND | 12 | 17 | ND | ND |
| Unknown Conjugated Compound | 8.6 T | ND | ND | ND | ND | ND |

Bold values exceed the CDPHE MCLs for the respective compound.
"T" = Tentatively identified compound

D 01060

| Table 9 Chlorinated Solvents in Ground Water (ug/L), 1991 WALSH Test Holes | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Compound | TH-6 | TH-9 | TH-11 | TH-12 | TH-14 | TH-15 | TH-16 | TH-18 |
| Tetrachloroethene | 4 J | 6 | 2 J | 2 J | 2 J | 2 J | 2 J | 5 |
| Methylene Chloride | 20 B | ND | ND | ND | ND | ND | ND | ND |
| 1, 1, 1-Trichloroethane | 8 | ND | 6 | 2 J | ND | 8 | ND | ND |

Bold values exceed the CDPHE MCLs for the compound.
"J" = Judged value
"B" = Indicates that the compound was found in the method blank and has been corrected.
ND = Not Detected

| Table 10 TVPH in Ground Water (ug/L), WALSH 1998 Test Holes | | | | | | | |
|---|---|---|---|---|---|---|---|
| Location | TH-19 | TH-20 | TH-21 | TH-22 | TH-23 | TH-24 | TH-25 |
| Concentration | ND | ND | ND | ND | ND | 1,100 | ND |

ND = Not Detected

D 01061

| Table 11 TVPH in Ground Water (ug/L), WALSH 1991 Test Holes | |
|---|---|
| **Location** | **Concentration** |
| TH-6 | ND |
| TH-7 | 1,964 |
| TH-9 | 78 |
| TH-10 | 58,360 |
| TH-10 (1998) | (770) |
| TH-11 | ND |
| TH-12 | ND |
| TH-13 | 276,470 |
| TH-14 | 32 |
| TH-15 | ND |
| TH-16 | 5 |
| TH-16 (1998) | (740) |
| TH-18 | 890 |
| TH-18 (1998) | (ND) |

ND = Not Detected
1998 results in parentheses.

## Table 12 Concentration of Metals in Groundwater (mg/L), WALSH 1998 Test Holes

| Metal | TH-19 | TH-20 | TH-21 | TH-22 | TH-23 | TH-24 | TH-25 | CGWS[1] (mg/L) |
|---|---|---|---|---|---|---|---|---|
| Arsenic | ND | ND | ND | ND | ND | ND | ND | 0.05 |
| Barium | 0.049 | 0.046 | 0.057 | 0.051 | 0.055 | 0.055 | 0.045 | 1.0 |
| Cadmium | ND | ND | ND | ND | ND | ND | ND | 0.005 |
| Chromium | ND | ND | ND | ND | ND | ND | ND | 0.05 |
| Lead | ND | ND | ND | ND | ND | ND | ND | 0.05 |
| Mercury | ND | ND | ND | ND | ND | ND | ND | 0.002 |
| Selenium | ND | ND | ND | ND | ND | ND | ND | 0.01 |
| Silver | ND | ND | ND | ND | ND | ND | ND | 0.05 |

[1] = Colorado Ground Water Standards, Human Health Standards (CDH, 1995). Bold values exceed CGWSs.
ND = not detected

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# Table 13 SOIL CONCENTRATIONS OF METALS (mg/Kg) AND TYPICAL LOCAL AND REGIONAL RANGES – HUMBOLDT/44TH STREETS TO BRIGHTON BOULEVARD (WALSH 1991)

| Metal | CDOT Mean[1] | CDOT Range | Western U.S. Range[2] | U.S. Typical Range[3] | TH-6 | TH-7 | TH-9 | TH-10 | TH-11 | TH-12 | TH-13 | TH-14 | TH-15 | TH-16 | TH-18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Arsenic | 5.5 | ND[5]-13 | 0.1-40 | 1-40 | 0.6 | 0.9 | ND | 0.7 | 0.6 | 0.8 | 0.9 | 32 | 7.0 | 4.0 | 1.0 |
| Barium | 563 | 13-1000 | 100-3000 | 100-3000 | 23 | 82 | 38 | 37 | 33 | 33 | 72 | 540 | 150 | 260 | 56 |
| Cadmium | 1.83 | ND-6 | 0.01-2 | 0.01-7 | ND | ND | 4 | ND | ND | ND | ND | **13** | 2 | 1.5 | ND |
| Chromium | 12.5 | ND-14 | 5-1500 | 5-3000 | ND | 8 | 2 | 2 | 1 | 6 | 3 | 32 | 9 | 5 | 4 |
| Lead | 33 | 1.8-80 | 2-300 | 2-200 | 2.0 | 5.0 | 3.4 | 2.7 | 3.8 | 3.6 | 4.0 | **710** | **170** | **210** | 6.1 |
| Mercury | <DL[4]-(0.1) | ND-0.2 | 0.01-0.055 | 0.010-0.08 | ND | ND | ND | ND | ND | ND | ND | **1.7** | ND | ND | ND |
| Selenium | <DL-(10) | ND-2 | 0.01-12 | 0.1-2 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Silver | <DL-(1) | ND-1 | 0.01-8 | 0.1-5 | ND | ND | ND | ND | ND | ND | ND | ND | ND | 1.0 | ND |
| Beryllium | 1 | ND-1 | 0.01-0 | 0.01-40 | ND | 0.5 | ND | ND | ND | ND | ND | 0.6 | ND | 0.6 | ND |
| Cobalt | 15 | ND-20 | 0.05-65 | 1-40 | ND | 5 | 5 | ND | ND | 3 | 2 | 6 | 5 | 3 | 3 |
| Copper | 38 | 4-54 | 2-250 | 2-100 | 4 | 11 | ND | 4 | 2 | 4 | 5 | 96 | 32 | 29 | 64 |
| Iron | 27600 | 2400-34000 | NV | 7000-550000 | 3000 | 9600 | 4000 | 3300 | 2500 | 5300 | 4000 | 11000 | 9400 | 7000 | 7500 |
| Manganese | 980 | 33-1700 | 200-10000 | 100-4000 | 55 | 160 | 120 | 190 | 120 | 120 | 140 | 230 | 340 | 180 | 120 |
| Nickel | 13.5 | ND-22 | 2-750 | 5-1000 | ND | 6 | 2 | 2 | ND | 3 | ND | 11 | 6 | 5 | 3 |
| Vanadium | 64 | 3-90 | 3-500 | 20-500 | 5 | 16 | 7 | 6 | 4 | 9 | 8 | 17 | 14 | 11 | 15 |
| Zinc | 132 | 9-330 | 1-900 | 10-300 | 14 | 44 | 18 | 12 | 10 | 16 | 13 | 740 | 230 | 180 | 21 |

(1) Calculated from 71 soil samples collected from CDOT projects in the Denver Metro Area.
(2) Bowen, 1979
(3) Dragun, 1988
(4) Detection Limit
(5) Not Detected
Bold numbers exceed U.S. Typical Ranges or local CDOT ranges for a particular metal.
TCLP values in parentheses.

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# Table 14 METALS IN GROUND WATER (mg/L) - WALSH 1991 MONITOR WELLS HUMBOLDT/44TH STREETS TO BRIGHTON BOULEVARD

| Metal | TH-6 | TH-7 | TH-9 | TH-10 | TH-11 | TH-12 | TH-13 | TH-14 | TH-15 | TH-16 | TH-18 | CGWS[1] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Arsenic | ND | ND | ND | ND | ND | ND | ND | ND | ND | 0.004 | ND | 0.05 |
| Barium | 0.05 | 0.13 | 0.06 | 0.15 | 0.05 | 0.06 | 0.11 | 0.05 | 0.04 | 0.06 | 0.04 | 1.0 |
| Cadmium | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 0.005 |
| Chromium | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 0.05 |
| Lead | ND | ND | ND | 0.002 | ND | ND | ND | ND | 0.002 | 0.005 | ND | 0.05 |
| Mercury | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 0.0002 | 0.002 |
| Selenium | 0.004 | ND | ND | ND | 0.005 | 0.003 | 0.003 | 0.003 | 0.007 | 0.005 | 0.004 | 0.01 |
| Silver | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 0.05 |
| Beryllium | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | |
| Cobalt | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | |
| Copper | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | |
| Iron | ND | ND | ND | ND | ND | 0.02 | ND | ND | ND | ND | ND | |
| Manganese | ND | 3.6 | ND | 3.9 | 0.04 | 0.21 | 5.0 | 0.03 | 0.12 | 0.42 | ND | |
| Nickel | ND | ND | ND | 0.02 | ND | ND | ND | ND | ND | ND | ND | |
| Vanadium | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | |
| Zinc | ND | ND | ND | ND | ND | 0.03 | ND | ND | ND | 0.02 | ND | |

[1] = Colorado Ground Water Standards, Human Health Standards (CDH, 1995). Bold values exceed CGWSs.
ND = not detected

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| Table 15 DISCHARGE PARAMETER RESULTS - WALSH 1991 HUMBOLDT/44TH STREETS TO BRIGHTON BOULEVARD | | | | | | | |
|---|---|---|---|---|---|---|---|
| Location | Alkalinity (mg/L) | TDS (mg/L) | Oil & Grease (mg/L) | COD (mg/L) | pH (units) | TSS (mg/L) | Gross Alpha<br>Gross Beta (pCi/L) |
| TH-6 | 370 | 1100 | ND | 7 | 6.9 | **53000** | No Data |
| TH-7 | 460 | 990 | 3 | 17 | 6.6 | **9800** | **131+/-40**<br>38.1+/-17.6 |
| TH-9 | 420 | 920 | ND | 16 | 6.7 | **17000** | **109+/-30**<br>33.6+/-17.6 |
| TH-10 | 520 | 1000 | ND | 82 | 7.0 | **17000** | No Data |
| TH-11 | 440 | 1000 | ND | 9 | 7.1 | **6000** | -1.0<br>3+/-13 |
| TH-12 | 460 | 1000 | 2 | 5 | 7.1 | **11000** | No Data |
| TH-13 | 590 | 1100 | ND | 51 | 7.2 | **21000** | **88+/-31**<br>10+/-13 |
| TH-14 | 450 | 1000 | ND | 18 | 7.1 | **5400** | No Data |
| TH-15 | 390 | 1000 | ND | 10 | 7.2 | **3200** | **83+/-39**<br>25+/-18 |
| Colorado Standard | None | none | 10 | none | 6.5 to 9 | 60 | 15<br>50 |

Bold values exceed Colorado standards for ground water discharge.